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as the pedicels. Furthermore, in *Holothuria floridana* at first the tentacles are provided with terminal suckers and these organs, like the primitive pedicels, are used for locomotion, while in feeding, as in the adult, they push food into the mouth. Admitting that the distal anal papillæ are modified pedicels, I think it is reasonable to consider the proximal oral tentacles as pedicels, only much more modified in the adult, for their special functions.

Östergren imagines the primitive form, or "Stammholothurie," as having had a soft body-wall containing spicules, and with five simple radial muscle bands, interrupting the transverse sheet of muscle. It moved by contractions of the body, and ate slime. The stone-canal was simple and opened on the outside of the skin. There were many pedicels and either ten or twenty tentacles without ampullæ. The calcareous ring had five radialia and perhaps five interradialia. The enteron was in three loops, the third in the right ventral inter-radius. The blood system did not expand into a *rete mirabile.* The posterior end of the enteron developed as a respiratory cloaca but respiratory trees were not present. There were no auditory vesicles. Östergren's primitive form was most nearly related to the present Elasipoda, and from it he shows how the five chief divisions of the class Holothurioidea may have evolved. Östergren employs as the names of these orders, Elasipoda, Aspidochirota, Dendrochirota, Molpadonia and Apoda (Synaptidæ, Chiridotidæ and Myriotrochidæ), and then concludes with a general description of the chief characters of each order.

CHARLES L. EDWARDS.

THE ENTEROPNEUSTA

Recent Literature on the Enteropneusta. 1. *Systematic.*—Spengel has lately given the classification of the Enteropneusta a thorough overhauling.[1] This accepted imperator in the knowledge of the group recognized at the time 31 species, 9 genera and 3 families. Since then 14 species and one genus have been added. Nearly all the new ones have come from the Pacific and Indian Oceans, these two enormous reservoirs of unknown organisms, the exploration of which has but recently begun in earnest. R. C. Punnett's report, The Enteropneusta in the "Fauna and Geography of the Maldive and Laccadive Archi-

[1] Die Benennung der Enteropneusten-Gattungen. *Zoolog. Jahrb.*, 15 Bd., pp. 209–218, 1901.

pelagoes,'' Vol. II, Part 2, pp. 631–680, 1903, stands first in point of numbers of new forms, 5 species and 1 genus being added in this, all but one coming from the island groups mentioned in the title. The exception, the type of the new genus Willeyia, comes from Zanzibar. Besides the 5 full-fledged new species recognized by Punnett, the 6 varieties of an old species *Ptychodera flava* are interesting. These are based on a statistical study of the 222 specimens in the collections. This is the first effort made to treat any of the Enteropneusta statistically, and is noteworthy on that account if for no other. The author's attitude toward the subject seems practical and sane. He remarks: ''I am not here concerned with the question of the statistical method as a criterion of species and varieties. My point is that in the group of animals collectively designated *Pt. flava* there are to be found different positions of organic stability, and in giving to these 'a local habitation and a name' there is no thought of distinguishing by statistical methods between the terms *race, variety* and *species.''* The only question would be as to the sufficiency in number of specimens examined and the structural features considered to justify all these subdivisions in this particular animal, and the question is to be answered only by further examination of more material.

The next largest numerical contribution is from the Siboga Expedition (Studien über die Enteropneusten der Siboga-expedition, Monographie XXVI, pp. 1–126, 1907, by J. W. Spengel). Three fully accredited species are here described. Worthy of note, perhaps of approval, is Spengel's practise, which is specially illustrated in this report, when dealing with certain forms which he finds to differ somewhat from any already recorded species, but yet not sufficiently to warrant giving them full specific rank on the basis of the small evidence at hand. To these he attaches a ''provisional'' specific name. Three such names are used in this report. They usually designate specimens from a particular geographic locality.

Spengel appears to be ever dubious about the specific identity of specimens of Enteropneusta occurring in widely separated places. Thus in his ''Neue Beiträge zur Kenntniss der Enteropneusten,'' I and II (*Zoolog. Jahrb.*, 1903 and 1904), he examines in great detail specimens of *Ptychodera flava* Eschsch. from Laysan, and concludes that they differ sufficiently from those described by Willey from New Caledonia, to deserve being treated provisionally, as distinct. Similarly he examines (Beitrag II) specimens from Funafuti and concludes that these are also recognizably different from those from the type locality. We consequently have as "provisional" designations *Ptychodera fl. caledoniensis, Pt. fl. laysanica,* and *Pt. fl. funafutica.* The author points out that while Funafuti (8° 30′ S.) lies between New Caledonia (20° S.) and Laysan (26° N.), *Pt. fl. funafutica* is not intermediate in structure between the other two forms.

One might, perhaps, question the utility of speaking of such designations as provisional when as a matter of fact no zoological name whatever can be confidently claimed to be final. In the reviewer's opinion there is, nevertheless, real merit in Spengel's practise. It seems to him that proof of the tendency of plant and animal kinds to break up into more kinds as soon as ready means of intercommunication is prevented, is so strong that the systematist is generally bound to suspect that specimens from widely separated localities (at least in many groups) are different until they are shown not to be so. This provisional naming might be looked upon as a recognition of this principle.

Another Pacific species is from Japan (On a new Enteropneust from Misaki, Balanoglossus misakiensis, n. sp.)[2] and another Indian Ocean one from the coast of India (Enteropneusta from Madras).[3]

Hardly less notable than the new species from the least explored parts of the sea is the bringing to light of new ones in the best explored parts. Spengel[4] describes a species of Glossobalanus from the Bay of Naples. The author well remarks that it is "sicher aufallend" that a new species represented by a single specimen should stand accredited to shallow water in the immediate vicinity of the Naples Zoological Station.

2. *Development.*—What must be counted as the most important contribution to Enteropneust development that has appeared since Bateson's series of papers, 1884–1886, has just been published by Dr. B. M. Davis (The Early Life-history of *Dolichoglossus pusillus* Ritter.[5] Davis had shown four years earlier that this California species develops without passing through a tornaria stage. *Dolichoglossus* (*Balanoglossus*) *Kowalevskii* of the Atlantic Coast of the United States, the species studied by

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[2] *Annot. Zool. japon.,* Vol. 4, 1902, pp. 77–84.

[3] *Quart. Journ. Micro. Sci.,* Vol. 47, 1903, pp. 123–131.

[4] Neue Beiträge III, *Zoolog. Jahrb.,* 20 Bd., 1904, pp. 315–362.

[5] *Univ. of California Publications in Zoology,* Vol. 4, 1908, pp. 187–228.

Bateson, develops directly also, it is hardly necessary to mention. Since the two species are much alike in most other respects as well, the desirability of examining the development of the Pacific species was obvious. The report before us is confessedly incomplete so far as the entire developmental history is concerned. In some of the phases treated it is, however, measurably full and apparently conclusive. The point of most importance perhaps as developmental problems are now estimated, pertains to the origin of the body cavities. Bateson seemed to find these to arise as five diverticula from the archenteron, viz., one anterior which produces the cavity of the pre-oral lobe, or in the final state the proboscis, a pair immediately behind this producing the cavities of the collar region of the adult, and behind these another pair which produces the cavities of the rest of the animal, *i. e.,* of the thoracic and abdominal portions.

Davis finds a radically different course of things. In the embryo studied by him a single anterior pouch arises as in *D. Kowalevskii,* but instead of the two pairs coming directly from the archenteron, the one anterior pouch sends back lateral pockets between the ectoderm and endoderm, and from these there is constricted off first a pair of cavities which correspond to the future collar, and then in turn from the posterior end of this collar pair, a second pair, presumably representing the future cavities of the thoracic-abdominal region of the adult, is cut off. Since Davis's results rest upon the examination of a large number of embryos (about one hundred and fifty series of sections, he tells us), preserved in a variety of ways and cut in various directions, it seems they must be accepted, and so the conclusion reached that either Bateson's interpretation of his sections was seriously erroneous, or that these two species so closely alike in most respects are unlike in this supposedly fundamental point. Davis strongly inclines to the first view and presents cogent reasons for his inclination based on a critical study of Bateson's text and figures.

The bearing of this finding on the problem of the relationship between Balanoglossus and Amphioxus is clear. The supposed similarity of origin of the body cavities has been taken as a leading proof of genetic kinship between the two animals. Davis does not fail to point out that his observations justify the doubts of the correctness of Bateson's conclusions entertained by both Spengel and Morgan and drawn from their studies of tornaria.

While Davis's work greatly weakens one of the strong supports of blood relationship between these two groups, it does not leave this weakening wholly uncompensated. It seems to find a number of striking resemblances between the egg cleavage of this particular enteropneust and that of Amphioxus. But this part of the study is less full and the significance of resemblance in these earlier developmental stages is more problematic. For the character of the correspondences here the reader must be referred to the paper itself.

3. *Ecology and Physiology.*—Ritter and Davis[6] have studied quite fully the movements of a tornaria of the California coast from near the beginning to the end of its pelagic career. A number of interesting facts pertaining to the character of the swimming movements, the correlation of these with its specific gravity, and this again with its structure are brought out.

Davis (paper on the development of *Dolichoglossus pusillus* already referred to) discusses some points on the distribution and migration of this species as dependent upon the movements of the animal during its larval period, and upon tidal action. Davis finds that the breeding time of *D. pusillus* in San Diego and Mission Bays is January and February, and that the fertilized eggs can be obtained from the burrows of the animals at low tide without great difficulty. Particularly noteworthy is the fact that in spite of the absence of a true tornaria, the young animal still does considerable swimming, and that this follows rather closely the general scheme previously found by Ritter and Davis to characterize the swimming of the tornaria of another species above alluded to.

Ritter[7] has studied the movements of the adult *Dolichoglossus pusillus* and a California species of *Balanoglossus* with the special view of gaining a better understanding of the action of the proboscis and skeletal musculatures and the relation of these to the skeleton. The results make it probable that the nuchal skeleton together with the so-called notochord serves not merely as a support for the isthmus, or neck, but also as an axis upon which the muscles of locomotion act, in part at least.

4. *Anatomy.*—The classification of the Enteropneusta is based

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[6] Studies on the Ecology, Morphology, and Speciology of the Young of Some Enteropneusta of Western North America. *Univ. of Calif. Publications, Zoology,* Vol. I, 1904, pp. 171–210.

[7] The Movements of the Enteropneusta and the Mechanism by which they are accomplished. *Biolog. Bull.,* Vol. III, pp. 255–261.

on a thoroughgoing examination of everything in the make-up of the animals, thanks particularly to the standard set by Spengel's splendid monograph of 1893. From this circumstance it follows that anatomical studies on the adults of either old or new species are not likely to yield greatly important new facts. A few points of considerable general interest, however, come from recent work.

The superficial, presumably secondary, metamerism of portions of the body in several species has attracted the attention of most observers. Willey and Spengel have given it special consideration. In no known species is this more strikingly seen, perhaps, than in the Neapolitan one lately described by Spengel. The prominence and regularity of the bilaterally arranged cross-welts or ridges on the ventral side of the genital region as figured by him, are remarkable indeed. It is not likely that these structures have any great significance either phylogenetic or physiological. They are probably in the main growth characters and are interesting on just this account.

In his extensive studies on the excretory organs of annelids and amphioxus some years ago, E. S. Goodrich predicted that a peculiar type of cells observed in these animals and called by him Solenocytes, would on special search be found in the Enteropneusta. Spengel has given attention to this point, with negative results so far. (Beitrag III.)

References may here be made to Spengel's tilts with Arthur Willey on the latter's speculations as to the vertebrate homologies of various Enteropneust organs. For example, Spengel examines with his accustomed thoroughness the dorsal nerve roots of the collar region in several species and treats with quite pungent sarcasm Willey's contention that in these we have the homologues of the vertebrate epiphysis. A fragment of this particular tilt is worth repeating as literature, though it may be questioned whether Willey ever took himself seriously enough in much of his theorizing on these matters to warrant giving his utterances much time under the aegis of real science. "An epiphyseal structure," Willey is quoted as saying, "like an enteropneustic root, can be transformed into an epiphyseal structure like a pineal eye by losing its primary function . . . passing through a condition of pigmentose degeneration . . . and then being rejuvenated by the acquisition of a new function." Then Spengel himself, "wo in aller Welt giebt es eine

Stütze für eine solche Annahme, dass ein pigmentoser Degeneration anheimgefallenes Organ einer Verjüngung durch Erwerbung einer neuen Funktion fähig wäre . . . ???—und dann schliesst gar der Satz, the agens of rejuvenescence being some form of natural selection! . . . heisst das etwa nicht, den Spöttern über die Selektionstheorie Wasser auf die Mühle tragen?! Es wird Einem ja schwindlig, wenn man an diesen babylonischen Turnbau nur denkt!"

W. E. Ritter.

VERTEBRATE PALEONTOLOGY

Pelycosauria of North America.[1]—There are few groups of animals at the present day of greater interest to the paleontologist and evolutionist than the extinct air-breathers of the Permian; and, of the Permian vertebrates, those of America, in their abundance, variety and excellence of preservation are easily the chief. As is well known, Professor Case has, for the past ten years or more, given much intelligent attention to the Permian reptiles of America, and especially to the group which he has described in the present handsome memoir as the "suborder" Pelycosauria. And the writer is inclined to think that he is a little too conservative here, for he believes that the structural characters are so diverse, so widely divergent from those of the modern Sphenodon, that to include them both in one and the same order is to hinder rather than advance an intelligent taxonomy of the reptiles. Mr. Case has given in the volume a complete history of the literature of the group, a taxonomic revision, a thorough discussion of the structural characters of the pelycosaurs, and the facts of their range and distribution. He has not, rather wisely, entered very fully into the many philosophical matters that the animals suggest. He expresses the opinion, however, that the pelycosaurs represent a highly specialized and short-lived branch of the rhynchocephalian stem, and in that he will probably have the concurrence of most paleontologists. But, to the writer, this does not seem altogether certain. The group has an abundance of generalized characters in the vertebræ, pectoral and pelvic girdles, cleithra, etc., the specialization consisting, for the most part, in the extraordinary and most bizarre elongation of the vertebral spines, the teeth, etc. His reasons for the grouping he makes are chiefly to be found in the temporal region of the skull; and the writer

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[1] Case, E. C. Revision of the Pelycosauria of North America. *Memoir of the Carnegie Institution of Washington*, pp. 1–176, pls. I–XXXV, 1907.